to show what you can do and prove to colleges that you are the candidate of choice—for admission, for advanced placement, for scholarships.

It's important, though, that you take the test in the right spirit. Don't be timid in the face of the ACT. Don't let it bully you. You've got to take control of the test. Our mission in this book is to show you exactly how to do that.

It helps to think of the ACT challenge as a contest—not only between you and the test, but also between you and that other person trying to get your spot in college. The ACT, after all, is meant to provide a way for all college applicants to compete on an even playing field. How do you compete successfully in a fair academic fight? You train—harder and smarter than the next person. First, you learn whatever knowledge and skills you need to know. Also, just as important, you learn how to show what you know, in ways that the test is designed to reward. You learn how to be a savvy test taker.

FOUR KEYS TO ACT SUCCESS

There are four basic keys to achieving ACT success. Following any of these by itself will improve your score. Following all four together will make you nothing less than awesome.

1. Learn the Test

The ACT is very predictable. You'd think the test makers would get bored after a while, but they don't. The same kinds of questions, testing the same skills and concepts, appear every time the ACT is given.

Because the test specifications rarely change, you can learn in advance what to expect on every section. Just a little familiarity can make an enormous difference on the ACT. Here are a few ways in which learning the test will boost your score:

- **You'll learn the directions.** Why waste valuable time reading directions when you can have them down pat beforehand? You need every second during the test to answer questions and get points.
- **You'll learn the difficulty range of questions.** It's a fact that a typical ACT test taker gets only about half the questions right. Knowing this will stop you from panicking when you hit an impossible science passage or trigonometry question. Relax! You can skip many tough questions on the ACT and still get a great score! And once you know that the questions aren't arranged in order of difficulty, you'll know that just beyond that awful question will be one, two, or even three easy questions that you can score on with no sweat at all.
- **You'll learn how to get extra points by guessing.** Unlike some other standardized tests, the ACT has no wrong-answer penalty. Knowing that simple fact can boost your score significantly. If you can't answer a question, guess.

The questions cover a full range of math topics, from pre-algebra and elementary algebra, to plane geometry and even a little bit of trigonometry. We'll tell you the exact number of questions in each area later, in Math Workout 1. If you have specific weaknesses in any of these areas, the 100 Key Math Concepts for the ACT section at the end of this book will help.

Although the Math questions, like those in other sections, aren't ordered in terms of difficulty, questions drawn from elementary school or junior high tend to come earlier in the section, while those from high school math curricula tend to come later. But this doesn't mean that the easy questions come first and the hardest ones come later. We've found that high school subjects tend to be fresher in most students' minds than things they were taught years ago, so you may actually find the later questions easier. (Do *you* remember the math you learned in seventh grade?)

The Directions

Here's what the Math directions will look like:

> **Directions:** Solve each problem, choose the correct answer, and then fill in the corresponding oval on your answer document.
>
> Do not linger over problems that take too much time. Solve as many as you can, then return to the others in the time you have left for this test.
>
> You are permitted to use a calculator on this test. You may use your calculator for any problems you choose, but some of the problems may best be done without using a calculator.

Note: Unless otherwise stated, all of the following should be assumed.

1. Illustrative figures are NOT necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word *line* indicates a straight line.
4. The word *average* indicates arithmetic mean.

EXPERT TUTOR TIP

"Do not waste any time on test day reading the directions."

Again, when it comes to directions on the ACT, the golden rule is: ***don't read them on test day!*** You'll already know what they say by the time you take the test.

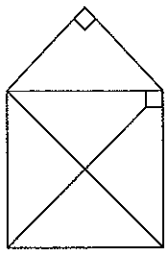
The Math directions don't really tell you much anyway. Of the four special notes at the end of the Math directions, #2, #3, and #4 almost go without saying. Note #1—that figures are not necessarily drawn to scale—seems pretty scary, but in fact, the vast majority of ACT figures are drawn to scale, and as we'll see, this has significant implications for how to guess on geometry questions.

Reading and Drawing Diagrams

We find that about a third of the Math questions either give you a diagram or describe a situation that should be diagrammed. For these questions, the diagrams are crucial.

Example

1. The figure below contains five congruent triangles. The longest side of each triangle is 4 meters long. What is the area of the whole figure?



A. 12.5 square meters
B. 15 square meters
C. 20 square meters
D. 30 square meters
E. Cannot be determined from the given information.

The key to this question is to let the diagram tell you what you need to know: that each triangle represents one-quarter of the area of the square and that the sides of the square are 4 meters (you can figure this out because the top side of the square is the hypotenuse—or longest side—of the triangle that makes the "roof"). Since the area of a square can be found by squaring the side, the area of the square is 16 square meters. Thus, each triangle has an area one-fourth as much—4 square meters. Since the whole figure consists of five triangles, each with area 4, the total area is $5 \times 4 = 20$. The answer is C.

EXPERT TUTOR TIP

In ACT Math questions, the answer choice "cannot be determined" is rare. When it does appear, it's usually wrong. "Cannot be determined" is **almost always** wrong in a question that comes with a diagram or for which you can draw one.

How to Approach a Story Problem

We find that about another third of the Math questions are story problems like the following:

Example

2. Evan drove halfway home at 20 miles per hour, then sped up and drove the rest of the way at 30 miles per hour. What was his average speed for the entire trip?

   F. 20 miles per hour
   G. 22 miles per hour
   H. 24 miles per hour
   J. 25 miles per hour
   K. 28 miles per hour

A good way to comprehend—and resolve—a story problem like this is to think of a real situation just like the one in the story. For example, what if Evan had 120 miles to drive? (You should pick a distance that's easily divisible by both rates.) He would go 60 miles at 30 mph, then 60 miles at 20 mph. How long would it take? Well, 60 miles at 30 mph is two hours; 60 miles at 20 mph is three hours. That's a total of 120 miles in five hours; 120 divided by 5 gives an average speed of 24 mph. The correct answer is thus H. (Note: We'll show you alternative ways to answer questions like this later on.)

Getting the Concept

Finally, we find that about a third of the questions directly ask you to demonstrate your knowledge of specific math concepts.

Example

3. If angles *A* and *B* are supplementary, and the measure of angle *A* is 57°, what is the measure, in degrees, of angle *B*?

   A. 33
   B. 43
   C. 47
   D. 123
   E. 147

This question simply requires that you know the concept of supplementary angles. Two angles are *supplementary* when they form a straight line—in other words, when they add up to 180°. Thus, question 3 boils down to this: what number, added to 57, makes 180? The answer is D.

These three types of Math questions, of course, will be discussed more fully in the Math Workouts.

The math concepts tested **do get harder** as you proceed through the section.

Mind-Set

- **The end justifies the means.** That means getting as many correct answers as quickly as possible. If that means doing straightforward questions in a straightforward way, that's fine. But many questions can be solved faster by unorthodox methods.
- **Take time to save time.** It sounds paradoxical, but to go your fastest on the Math test, you've got to slow down. **Never** dive in headlong, wildly crunching numbers or manipulating equations without first giving the problem some thought.
- **When in doubt, shake it up.** ACT Math questions are not **always** what they seem at first glance. Sometimes all you need is a new perspective to break through the disguise.

The Kaplan Method

1. **Understand.** First focus on the question stem and make sure you understand the problem. Underlining what the question is asking might help you. If it is a word problem and you are completely lost, try taking notes. You will pull out the information that is necessary to solve the problem. Think to yourself: "What kind of problem is this? What am I looking for? What am I given?"
2. **Analyze.** Think for a moment and decide on a plan of attack.
   - **Math skills.** Do you know how to solve the problem using your math knowledge? Go for it!
   - **Picking numbers.** Are there variables in the answer choices? If so, is there a way to pick numbers for the variable to help you get to the right answer?
   - **Back-solving.** Are there numbers in the answer choices? What is the question asking for? That is what the numbers in the answer choices represent. Is there a way to use the answer choices to get to the right answer?
3. **Select.** Once you get an answer, does it match one of the answer choices? If so, circle the answer in your test book and fill in the appropriate bubble on your answer grid. If you are stuck, circle the problem in your test book and move on to get all your "easy" points first! Come back to this problem after you have gone through the entire test.

We offer several recommendations for what to do when you get stuck. If after a few moments of thought, you find you still can't come up with a reasonable way of doing the problem, try one of these techniques:

1. **Restate.** When you get stuck, try looking at the problem from a different angle. Try rearranging the numbers, changing decimals to fractions, fractions to decimals, multiplying out numbers, factoring problems, redrawing a diagram, or anything that might help you to look at the problem a bit differently.

2. **Remove the disguise.** A problem might look like a different problem sometimes! Find out what the question is really asking, and it might not be what the problem looks like it would be asking. See Math Workout 2 for some examples!
3. **Try eyeballing.** Even though the directions warn you that diagrams are "not necessarily" drawn to scale, eyeballing is a surprisingly effective guessing strategy. Unless a problem says "Note: Not drawn to scale," you can assume that it is drawn to scale! Use that to help you eliminate answer choices that you know are wrong!

Timing

Remember the Two-Pass Approach. **Spend about 45 minutes on your first pass through the Math subject test: do the easier questions, guess on the questions you know you'll never get, and mark the tough ones that you'll want to come back to.** Spend the last 15 minutes picking up those questions that you skipped on the first pass.

We recommend that you grid your answers at the end of every page or two. In the last five minutes or so, start gridding your answers one by one. And make sure that you have an answer (even if it's a blind guess) gridded for every question by the time the test is over.

Don't worry if you have to guess on a lot of the Math questions. You can miss a lot of questions on the subject test and still get a great score. **Remember that the average ACT test taker gets fewer than half the Math questions right!**

When You're Running Out of Time

If at some point you realize you have more questions left than you have time for, be willing to skip around, looking for questions you understand right away. Pick your spots. Concentrate on the questions you have the best chance of correctly answering. Just be sure to grid an answer—even if it's just a wild guess—for every question.

Scoring

Your performance on the Math subject test will be averaged into your ACT Composite Score, equally weighted with your scores on the other three major subject tests. You will also receive:

- Math subject score—from 1 to 36—for the entire Math subject test
- Pre-Algebra/Elementary Algebra subscore—from 1 to 18
- Intermediate Algebra/Coordinate Geometry subscore—from 1 to 18
- Plane Geometry/Trigonometry subscore—from 1 to 18

Know When to Skip

At any time during the three-step process, you could choose to cut bait and skip the question. **Almost everyone should skip at least some questions the first time through.**

If you know your own strengths and weaknesses, you can sometimes choose to skip a question while still in Step 1: Understand. For example, suppose you **never** studied trigonometry. Maybe you think that a secant is something that sailors sing while climbing up the yardarms. Well, the ACT includes exactly four trigonometry questions, and it's not hard to spot them. Why waste a second on such questions? Skip them! You don't need those four measly questions to get a great score. And since you know a second visit later won't help any, you might as well go ahead and make some random guesses.

It can be harder to decide when to skip a question if you understand it, but then get stuck in Step 2: Analyze. Suppose you just don't see how to solve it. Don't give up too quickly. Sometimes it takes 30 seconds or so before you see the light. But don't get bogged down either. **Never** spend more than a minute on a question the first time through the section. No single question is worth it. Be prepared to leave a question and come back to it later. Often, on the second try, you'll see something you didn't see before. That old lightbulb will light up over your head and you'll be on your way.

Of course, eventually you're going to grid in an answer choice for every question, even the ones you don't understand. **The first time through the section, however, you should concentrate on the questions you understand.**

EXPERT TUTOR TIP

"The fastest way to a higher score on the ACT is to get all your easy points first—skip those hard problems, and go back to them later if you have time."

EXPERT TUTOR TIP

"If you need to take a random guess, guess the same letter for every question you need to guess on throughout the ACT. This will increase your chance of getting some points off of those guesses."

KAPLAN'S TWO-PASS PLAN FOR ACT MATH

We recommend that you plan two passes through the Math test.

- **First pass:** Examine each problem in order. Do every problem you understand. Don't skip too hastily—sometimes it takes a few seconds of thought to see how to do something—but don't get bogged down. **Never** spend more than a minute on any question in the first pass. This first pass should take about 45 minutes.
- **Second pass:** Use the last 15 minutes to go back to the questions that stumped you the first time. Sometimes a fresh look is all you need—after going away and then coming back you'll sometimes suddenly see what to do.

Be sure to select an answer for every question, even if it's just a blind guess.

Don't plan on visiting a question a third time; it's inefficient to go back and forth that much. Every time you leave a question and come back to it, you have to

Example

9. $\sin 495° =$

F. $-\frac{\sqrt{2}}{2}$

G. $-\frac{1}{2}$

H. $\frac{1}{2}$

J. $\frac{\sqrt{2}}{2}$

K. $\frac{3\sqrt{2}}{2}$

Without a calculator, this is a very difficult problem. To find a trigonometric function of an angle greater than or equal to 90°, sketch a circle of radius 1 which is centered at the origin of the coordinate grid. Start from the point (1, 0) and rotate the appropriate number of degrees counterclockwise. When you rotate counterclockwise 495°, you rotate 360° (which brings you back to where you started), and then an additional 135°. That puts you midway into the second quadrant. Now you need to know whether sine is positive or negative in the second quadrant. Pretty scary, huh?

With a calculator, this problem becomes simple. Just punch in "sin 495°" and you get 0.7071067811865. Choices F and G are negative, so they're out, and 0.7071067811865 is clearly not equal to $\frac{1}{2}$, so H is also wrong. That leaves only J or K. Now, with respect to choice K: $\sqrt{2}$ is greater than 1, so if you multiply it by another number greater than 1 (namely $\frac{3}{2}$), the result is obviously greater than 1. So you can eliminate K, leaving J as the correct answer. With a calculator, you can get this question right without really understanding it.

The key to effective calculator use is practice, so don't run out the night before the test to buy a fancy new calculator. If you don't already have a calculator (and intend to use one on the test), buy one now. Unless you're studying math or science in college, you won't need anything more complex than trig functions. You're better off bringing a straightforward model you're familiar with than an esoteric model you don't know how to use.

Practicing with your calculator is the best way to get a sense of where it can help and save time. Here's a brief guide to spotting those calculator-friendly Math questions.

EXPERT TUTOR TIP

When doing trig functions, make sure that your calculator is in degree mode—unless the answers contain π, in which case you have to use radians.

EXPERT TUTOR TIP

Pocket organizers, cell phones, computers, models with writing pads, paper tapes, power cords, wireless transmitters, calculators that are noisy, and Kray supercomputers are **not** allowed on test day.

CHAPTER 7: MATH WORKOUT 1: THE END JUSTIFIES THE MEANS

IF YOU LEARN ONLY FOUR THINGS IN THIS CHAPTER . . .

1. Look for the quickest ways to solve problems. Sometimes this requires creative thinking.
2. Use the answer choices to help you. If you are stuck, can you plug numbers in for the variables or use the numbers in the answer choices to get to the correct answer?
3. Follow Kaplan's Two-Pass Plan: skip problems that are more difficult, and come back to them after you've finished the easy ones.
4. Practice with your calculator so you are comfortable using it—and understand when it is faster not to use it.

Your goal on the Math subject test is to get as many correct answers as you can in 60 minutes. It doesn't matter what you do (short of cheating, naturally) to get those correct answers.

You don't have to do every problem the way your math teacher would. **Be open to clever and original solution methods.** All that matters is that your methods be quick and that they get you a solid number of correct answers. How many correct answers you need depends on what kind of score you're aiming for, but chances are you don't have to get so many right as you might think to get a good score. Yes, it's a tough test, but it's graded on a curve.

As we've pointed out, the ACT is different from the typical high school test. On a typical high school math test, you get a series of problems just like the ones you've been doing in class. Since you're being tested on a relatively narrow scope of topics, you're expected to get almost every question right.

EXPERT TUTOR TIP

Here's how to use this chapter if you don't have much time. Learn the Kaplan Method for ACT Math, trying the sample questions that follow. Read the sidebars throughout the whole chapter for quick ACT strategy tips.

ACT Math is different. The scope of what's tested is deliberately wide so that every student will get an opportunity to demonstrate his or her strengths, wherever they may lie.

The average ACT student gets fewer than half of the Math questions right. **You need only about 40 correct answers to get your Math score over 25—just two right out of every three questions gets you a great score!**

THE ACT MATH MIND-SET

According to an old legend at MIT, a physics professor once asked the following question on a final exam: *How could a barometer be used to determine the height of a tower?*

To answer the question, most students worked out complex equations based on the fact that air pressure (which is what a barometer measures) decreases at higher altitudes. But one student made three suggestions instead:

1. Measure the length of the barometer, then use the barometer as a ruler and measure the tower.
2. Drop the barometer and time its fall, keeping in mind that the acceleration of falling objects is about 32 ft/sec^2.
3. Find the person who built the tower and say, "I'll give you a nice barometer if you tell me how tall your tower is."

Guess which student got an A . . .

On the ACT, as in college and beyond, you'll sometimes be called upon to do more than merely regurgitate memorized facts and unquestioningly follow prepackaged procedures. True, some ACT Math questions are straightforward: as soon as you understand what the question's asking, you know what to do. But more challenging—and more fun (really)—are the ACT Math questions that aren't what they seem at first glance. These are the questions that call for creative solutions.

Don't Be Obedient

On the ACT, there's no partial credit. All that matters is the right answer. It makes no difference how you find it. In fact, as we'll see, it's sometimes safer and faster if you don't do ACT problems the "right" way—the way you've been taught in school. For a lot of ACT Math problems, there's more than one way to find the answer. And many of these other ways are faster than the so-called right way.

If you do every problem the way your algebra teacher would want you to, you may earn his or her undying gratitude, but you won't achieve your goal of getting as many correct answers as possible. **You don't have time to use the textbook approach on every question. You don't have time to write out every step.**

Pick Numbers

Sometimes you can get stuck on an algebra problem because it's too general or abstract. A good way to get a handle on such a problem is to make it more explicit by temporarily substituting numbers for the variables.

Example

1. If a is an odd integer and b is an even integer, which of the following must be odd?
   A. $2a + b$
   B. $a + 2b$
   C. ab
   D. a^2b
   E. ab^2

Rather than try to think this one through abstractly, it's easier to pick numbers for a and b. There are rules that predict the evenness or oddness of sums, differences, and products, but there's no need to memorize those rules. When it comes to adding, subtracting, and multiplying evens and odds, what happens with one pair of numbers generally happens with all similar pairs.

Just say, for the time being, that $a = 1$ and $b = 2$. Plug those values into the answer choices, and there's a good chance only one choice will be odd:

A. $2a + b = 2(1) + 2 = 4$
B. $a + 2b = 1 + 2(2) = 5$
C. $ab = (1)(2) = 2$
D. $a^2b = (1)^2(2) = 2$
E. $ab^2 = (1)(2)^2 = 4$

Choice B was the only odd one for $a = 1$ and $b = 2$, so it *must* be the one that's odd no matter *what* odd number a actually stands for and even number b actually stands for.

Back-Solve

With some ACT Math problems, it may actually be easier to try out each answer choice until you find the one that works, rather than attempt to solve the problem and then look among the choices for the answer. Since this approach involves working backwards from the answer choices to the question stem, it's called back-solving. Here's a good example:

EXPERT TUTOR TIP

"Answer choices are generally listed in numerical order. If the first number you try doesn't work, the process of plugging in that first number might tell you whether you'll need a smaller or a larger number. So when back-solving, start with the middle choice (C or H) to be safe."

Example

2. All 200 tickets were sold for a particular concert. Some tickets cost $10 apiece, and the others cost $5 apiece. If total ticket sales were $1,750, how many of the more expensive tickets were sold?

   F. 20
   G. 75
   H. 100
   J. 150
   K. 175

There are ways to solve this problem by setting up an equation or two, but if you're not comfortable with the algebraic approach to this one, why not just try out each answer choice?

Start with choice H. If 100 tickets went for $10, then the other 100 went for $5. 100 at $10 is $1,000, and 100 tickets at $5 is $500, for a total of $1,500—too small. There must have been more than 100 $10 tickets.

Try choice J next. If 150 tickets went for $10, then the other 50 went for $5. So 150 tickets at $10 is $1,500, and 50 tickets at $5 is $250, for a total of $1,750—that's it! The answer is J.

Back-solving your way to the answer may not be a method you'd show your algebra teacher with pride—but your algebra teacher won't be watching on test day. Remember, all that matters is right answers—it doesn't matter how you get them.

Be a Thinker—Not a Number Cruncher

EXPERT TUTOR TIP

"You will not get credit for anything you write under "DO YOUR FIGURING HERE." You get credit only for answers correctly gridded into the bubbles on your answer sheet."

One reason you're given limited time for the Math subject test is that the ACT is testing your ability to think, not your willingness to do a lot of mindless calculations. So one of your guiding principles for ACT Math should be: **work less, but think harder.**

If you want to get the best score you can, be on the lookout for quicker ways to solve problems. Here's an example that could take a lot more time than it needs to:

Example

3. When $\frac{4}{11}$ is converted to a decimal, the 50th digit after the decimal point is:

   A. 2
   B. 3
   C. 4
   D. 5
   E. 6

It seems that when you convert $\frac{4}{11}$ to a decimal, there are at least 50 digits after the decimal point. The question asks for the 50th. One way to answer this question would be to divide 11 into 4, carrying the division out to 50 decimal places. That method would work, but it would take forever. It's not worth spending that much time on one question.

No ACT Math question should take more than a minute to take care of, if you know what you're doing. There has to be a faster way to solve this problem. There must be some kind of pattern you can take advantage of. And what kind of pattern might there be with a decimal? How about a *repeating* decimal?!

In fact, that's exactly what you have here. The decimal equivalent of $\frac{4}{11}$ is a repeating decimal: $\frac{4}{11} = .3636363636\ldots$

The 1st, 3rd, 5th, 7th, and 9th digits are each 3. The 2nd, 4th, 6th, 8th, and 10th digits are each 6. Put simply, odd-numbered digits are 3s and even-numbered digits are 6s. The 50th digit is an even-numbered digit, so it's a 6 and the answer is E.

What looked at first glance like a fractions and decimals problem turned out to be something of an odds and evens problem. If you don't use creative shortcuts on problems like this one, you'll get bogged down, you'll run out of time, and you won't get a lot of correct answers.

Question 3 demonstrates how the ACT designs problems to reward clever thinking and to punish students who blindly "go through the motions." But how do you get yourself into a creative mind-set on the Math test? For one thing, you have to take the time to understand each problem you decide to work on. Most students are so nervous about time that they skim each math problem and almost immediately start computing with their pencils. But that's the wrong way of thinking. **Sometimes you have to *take* time to *save* time.** A few extra moments spent understanding a math problem can save many extra moments of computation or other drudgery.

EXPERT TUTOR TIP

Don't rely on your calculator for every operation. It's there to supplement your skills, not to replace them.

EXPERT TUTOR TIP

Underlining what the question is asking will help you to make sure you choose the correct answer.

THE KAPLAN THREE-STEP METHOD FOR ACT MATH

At Kaplan, we've developed this take-time-to-save-time philosophy into a three-step method for ACT Math problems. The approach is designed to help you find the fast, inventive solutions that the ACT rewards. The steps are:

STEP 1: UNDERSTAND

Focus first on the question stem (the part before the answer choices) and make sure you understand the problem. Sometimes you'll want to read the stem twice or rephrase it in a way you can better understand. Think to yourself: "What kind

which sounds pretty good. Choice C—2π—would be something more than 6. Already that's way too big. Choices D and E are even bigger. It sure looks like the answer has to be B—and it is.

Not many ACT students would be able to solve question 5 the textbook way. If you could, great! Solving the problem is *always* more reliable than eyeballing. But when you *don't* know how to solve a diagram problem, or if you think it would take forever to get an answer, eyeballing and eliminating answer choices sure beats wild guessing. Sometimes, as with question 5, you might even be able to narrow the choices down to the one that's probably correct.

TYPICAL STORY PROBLEMS

We find that about one-third of the questions on the Math test are Story Problems. Though some Story Problems present unique situations that must be analyzed on the spot, others are just variations on familiar themes.

PERCENT PROBLEMS

In Percent Problems, you're usually given two numbers and asked to find a third. The key is to identify what you have and what you're looking for. In other words, identify the part, the percent, and the whole.

Put the numbers and the unknown into the general form:

Part = Percent × Whole

Usually the part is associated with the word *is*, and the whole is associated with the word *of*.

Example

6. In a group of 250 students, 40 are seniors. What percentage of the group are seniors?

   F. 1.6%
   G. 6.25%
   H. 10%
   J. 16%
   K. 40%

The percent is what we're looking for ("What percentage . . ."); the whole is 250 ("... of the group . . ."); and the part is 40 ("... are seniors"). Plug these into the general formula:

$$\text{Part} = \text{Percent} \times \text{Whole}$$
$$40 = 250x$$
$$x = \frac{40}{250} = .16 = 16\%$$

The answer is J.

Many ACT Percent Problems concern percent change. To increase a number by a certain percent, calculate that percent of the original number and add it on. To decrease a number by a certain percent, calculate that percent of the original number and then subtract. For example, to answer the question, "What number is 30% greater than 80?" first find 30% of 80—that's 24—and add that on to 80: 80 + 24 = 104.

The ACT has ways of complicating percent change problems. Especially tricky are problems with multiple changes, such as a percent increase followed by another percent increase or a percent increase followed by a percent decrease.

Example

7. If a positive number is increased by 70 percent, and then the result is decreased by 50 percent, which of the following accurately describes the net change?

   A. a 20 percent decrease
   B. a 15 percent decrease
   C. a 12 percent increase
   D. a 20 percent increase
   E. a 120 percent increase

To get a handle on this one, pick a number. Suppose the original number is 100. After a 70 percent increase, it rises to 170. That number, 170, is decreased by 50 percent, which means it's reduced by half to 85. The net change from 100 to 85 is a 15 percent decrease—choice B.

Average Problems

Instead of giving you a list of values to plug into the average formula, ACT Average Problems often put a slight spin on the question. They tell you the average of a group of terms and ask you to find the value of the missing term. Here's a classic example:

Example

8. To earn a B for the semester, Linda needs an average of at least 80 on the five tests. Her average for the first four test scores is 79. What is the minimum score she must get on the fifth test to earn a B for the semester?

   F. 80
   G. 81
   H. 82
   J. 83
   K. 84

EXPERT TUTOR TIP

Picking numbers is a good strategy when the answer choices are all percents. And 99 percent of the time the best number to pick—the easiest to work with—will be 100.

EXPERT TUTOR TIP

Back solving is a fast way to work through Average Problems. Question 7 asks for the minimum score, so start with 80. Try plugging that in for the fifth test score.

The key to almost every Average Problem is to use the sum. Sums can be combined much more readily than averages. An average of 80 on five tests is more usefully thought of as a combined score of 400. To get a B for the semester, Linda's five test scores have to add up to 400 or more. The first four scores add up to $4 \times 79 = 316$. She needs another 84 to get that 316 up to 400. The answer is K.

Weighted Average Problems

Another spin ACT test makers put on Average Problems is to give you an average for part of a group and an average for the rest of the group, and then ask for the combined average.

Example

9. In a class of 10 boys and 15 girls, the boys' average score on the final exam was 80 and the girls' average score was 90. What was the average score for the whole class?

   A. 83
   B. 84
   C. 85
   D. 86
   E. 87

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The probability of what *will* happen is not affected by what already *has* happened. Whenever you flip a coin, the probability is $\frac{1}{2}$ that it will be heads. Even if you flip the coin and get heads ten times in a row, the probability is still $\frac{1}{2}$ on the 11th flip. Of course, the odds against 11 heads in a row are huge, but once the first ten flips are history they're no longer relevant.

Don't just average 80 and 90 to get 85. That would work only if the class had exactly the same number of girls as boys. In this case, there are more girls, so they carry more weight in the overall class average. In other words, the class average should be somewhat closer to 90 (the girls' average) than to 80 (the boys' average).

As usual with averages, the key is to use the sum. The average score for the whole class is the total of the 25 individual scores divided by 25. We don't have 25 scores to add up, but we can use the boys' average and the girls' average to get two subtotals.

If 10 boys average 80, then their 10 scores add up to 10×80, or 800. If 15 girls average 90, then their 15 scores add up to 15×90, or 1,350. Add the boys' total to the girls' total: $800 + 1{,}350 = 2{,}150$. That's the class total, which can be divided by 25 to get the class average: $\frac{2{,}150}{25} = 86$. The answer is D.

Probability Problems

Probabilities are part-to-whole ratios. The whole is the total number of possible outcomes. The part is the number of favorable outcomes. For example, if a drawer contains two black ties and five other ties and you want a black tie, the total number

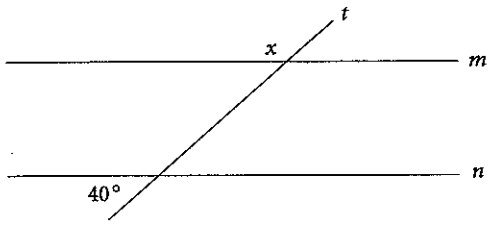
of possible outcomes is seven (the total number of ties), and the number of favorable outcomes is two (the number of black ties). The probability of choosing a black tie at random is $\frac{2}{7}$.

WHAT TO DO NEXT

Because more than half the Math questions on the ACT involve algebra, it's a good idea to solidify your understanding of the basics before test day. Focus on #52–70 in 100 Key Math Concepts for the ACT. Keep things in perspective. **Geometry questions are important, too, but algebra questions are more important.**

Example

1. In the figure below, line t crosses parallel lines m and n. What is the degree measure of $\angle x$?

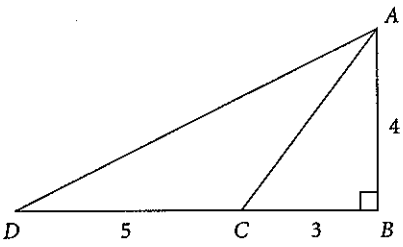


A. 40
B. 50
C. 60
D. 130
E. 140

2. What is the slope of the line perpendicular to the equation $4x+3y=9$?

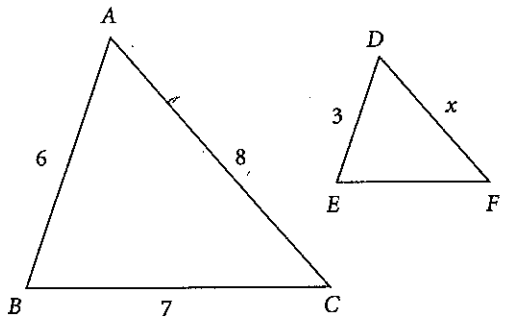
F. $-\frac{4}{3}$
G. $-\frac{3}{4}$
H. $\frac{4}{3}$
J. $\frac{3}{4}$
K. 3

3. In the figure below, $\angle B$ is a right angle and the lengths of $\overline{AB}$, $\overline{BC}$, and $\overline{CD}$ are given in units. What is the area of ΔACD, in square units?



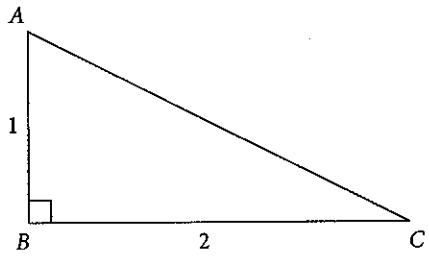
A. 10
B. 12
C. 16
D. 20
E. 32

4. In the figure below, ΔABC is similar to ΔDEF. $\angle A$ corresponds to $\angle D$, $\angle B$ corresponds to $\angle E$, and $\angle C$ corresponds to $\angle F$. If the given lengths are of the same unit of measure, what is the value of x?



F. 3
G. 3.5
H. 4
J. 5
K. 6

5. In ΔABC below, $\angle B$ is a right angle. If $\overline{AB}$ is 1 unit long and $\overline{BC}$ is 2 units long, how many units long is $\overline{AC}$?

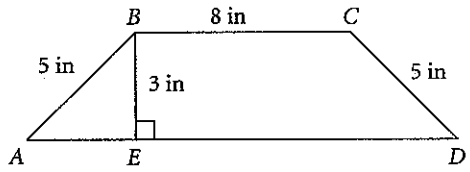


A. $\sqrt{2}$
B. $\sqrt{3}$
C. 2
D. $\sqrt{5}$
E. 3

6. Point P (−3, 5) and point Q (0, 1) are points on the *x*-*y* coordinate plane. What is the distance between points P and Q?

   F. 4
   G. 5
   H. 6
   J. 7
   K. 8

7. In the figure below, $\overline{BE}$ is perpendicular to $\overline{AD}$, and the lengths of $\overline{AB}$, $\overline{BC}$, $\overline{CD}$, and $\overline{BE}$ are given in inches. What is the area, in square inches, of trapezoid *ABCD*?

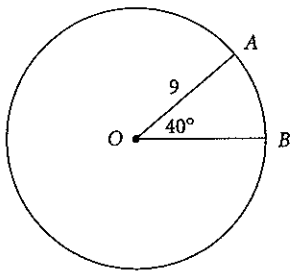


   A. 24
   B. 30
   C. 32
   D. 34
   E. 36

8. What is the area, in square inches, of a circle with a diameter of 8 inches?

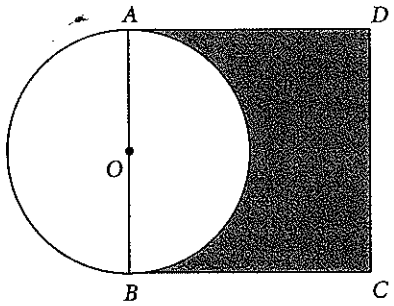
   F. 4π
   G. 8π
   H. 16π
   J. 32π
   K. 64π

9. In the circle centered at *O* in the figure below, the measure of $\angle AOB$ is 40°. If $\overline{OA}$ is 9 units long, how many units long is minor arc *AB*?



   A. π
   B. 2π
   C. 9
   D. 9π
   E. 40

10. In the figure below, *ABCD* is a square and $\overline{AB}$ is a diameter of the circle centered at *O*. If $\overline{AD}$ is 10 units long, what is the area, in square units, of the shaded region?



   F. $100 - 50\pi$
   G. $100 - 25\pi$
   H. $100 - \frac{25\pi}{2}$
   J. $100 - 10\pi$
   K. $100 - 5\pi$